Role of Fingerprints Patterns and ABO/Rh Blood Groups in Sex Dimorphism Among Egyptian Population Sample

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Fingerprint Patterns, ABO/Rh Blood Groups, Sex Dimorphism, Egyptian Population.

ABSTRACT

Fingerprints have been used as an accurate method of personal identification for a long time. The present work was carried out to screen fingerprint patterns in different ABO/Rh blood groups and study their role in sex determination in a selected sample of the Egyptian population. This study was conducted with 200 undergraduate medical students in the Faculty of Medicine at Mansoura University. Blood samples were collected and analyzed for ABO/Rh blood categories. Finger-tip prints on both hands were taken from white A4 paper using black washable ink. A magnifying glass was used to detect the pattern in all fingerprints.A magnifying hand lens was used to detect the pattern in all fingerprints. The most common type of fingerprint patterns was an ulnar loop in both genders with a statistically significant difference between males and females in right index, right middle finger, and left ring finger distribution patterns. Right hand fingerprints can have a more suggestive value for gender determination than the left hand in the Egyptian population. There was a highly statistically significant difference between males and females in "O+ and "B+" blood groups with a highly statistically significant difference in fingerprint patterns distribution in "A+, O- and AB-" blood groups. Moreover, there was an association between fingerprint patterns and the distribution among blood groups "O-. B+, B-, AB+" on gender. Gender prediction in certain blood groups may be possible based on fingerprint patterns. Digital patterns, loops, whorls, and arches remain an important feature for the identification of gender and of possibly determining ethnic groups.

Introduction

An individual's identity is defined by a set of physical traits, both functional and pathological. Several well known procedures can help in human identification such as Odontology, fingerprints, Cheiloscopy, Anthropometry, DNA analysis, and other different biometric methods that are used to determine gender among populations (Reddy, 2011). Among all, finger tip study is considered the least invasive and least cost-effective technique. (Tandon et al., 2017).

A fingerprint is an imprint of the curving lines of skin at the end of a finger that is left on a surface or created by pressing an inked finger against the paper. Individual fingerprints are the most trustworthy basis for identification since they are unique (Ahmed et al., 2017). They first appear on the fingers, palms, soles and toes between the 12th and 16th weeks of embryonic development, and by the 14th week, their construction is finished. The skin covering the anterior surface of the human hand and the insole is different in texture and appearance **of** the skin that covers

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the rest of the body. From birth to death, it is wrinkled with tiny ridges known as friction ridges that are consistent and distinctive, even in monozygous twins. (Moore et al., 2009). The ridges developed in the foetal stage do not alter throughout the life of the individual until they are dissolved by skin decomposition after death (Sandhu et al., 2017).

Some medications can alter the appearance of fingerprints such as sulfonamides, NSAIDs, anticonvulsants, and capecitabine; the anti-cancer drug (Habif, 2004 and Wong et al., 2009). Tinea manus, pyoderma, keratolase bite, lichen planus, pyogenic granuloma, and systemic sclerosis are examples of skin diseases that cause the destruction of the skin's dermis and epidermis. In addition, hand eczema is a chronic inflammatory skin disease that has been associated with certain occupations such as hairdressers, nurses, and workers exposed to cement and mortar. Repeated attacks of the hand ezcema can cause pathological changes in the epidermis and upper dermis leading to alteration of fingerprints. (Drahansky et al., 2012). Dermatoglyph is a sporadic genetic disorder that causes an individual to have no finger prints. People with this disorder have fully smooth tips, palms, toes and soles (Burger et al., 2011).

The main types of fingerprints include arches, loops, and vertibera. The arches are the most simple and rare of all patterns, while the loop is the most widespread (David, 1981). The whorl pattern has two deltas, the loop pattern has one delta, and the arch pattern has none. According to the side of the loop opens, the loop model is still split into radial and ulnar loops. Due to their unique characteristics, fingerprints have a very significant forensic investigation value in identifying different human phenotypes (Kumbnani, 2007). The usefulness of fingertips models in determining ethnic and gender differences has been highlighted in some previous studies (Osunwoke et al., 2008, Ahmed and Osman, 2016). But little has been done in this regard within the Egyptian population.

The blood type system was discovered in 1901 by Karl Landsteiner, a Viennese pathologist (Storry and Olsson, 2009). A total of 30 human blood groups have been identified by the International Society of Blood Transfusion. Only the ABO and Rhesus groups show clinical significance (Sudikshya et al., 2018). The ABO system is further classified into blood groups A, B, AB, and O depending on the presence of the corresponding antigen in the plasma. The "Rhesus" system is one of the most complex blood groups in humans and it is further classified into either Rh +ve or Rh -ve according to the presence or absence of the D antigen. Blood type is considered another biological record that remains unchanged over the lifetime of an individual and contributes to personal identification and forensic investigations (Sandhu et al., 2017).

There is no doubt that fingerprint evidence is the most reliable and acceptable evidence to date before court (Tandon et al., 2017). Because of the enormous potential of fingerprints as a reliable means of identification, this research is considered to be another step in "studying the relationship between fingerprints patterns, ABO/Rh blood groups, and gender", so that we can get an idea of the expected blood type and gender from the study of fingertips models and vice versa.

The current work aims to examine fingerprints in various ABO/Rh blood groups and to study their role in determining sex in a selected sample of the Egyptian population.

Subjects and Methods:

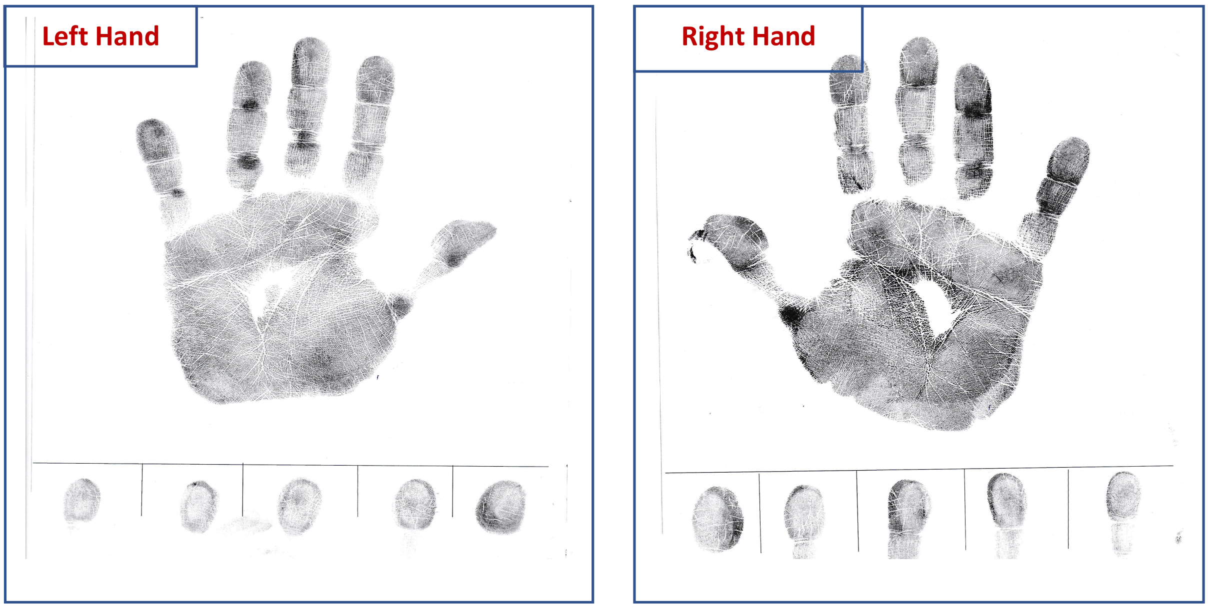
This study is a prospective cross-section study that was conducted on 200 healthy undergraduate medical students at the Faculty of Medicine, Mansoura University between January 1, 2020 and February 1, 2021. The study was approved by the Institutional Review Board (IRB) and assigned a code number (R/21.05.1342).

- ***Inclusion Criteria:*** Subjects were gendered (100 males & 100 females) with the same ethnic group, their age was between 20-24 years. All participants voluntarily gave their informed written consent to participate in this study. Confidentiality of all subjects was preserved without a declaration of identity.

- ***Exclusion Criteria:*** Any participant with finger trauma or surgical scars, finger deformity, congenital abnormality (extra and webbed fingers), or amputated fingers were excluded. Subjects with active or chronic skin lesions in the hand or receiving chemotherapy were also excluded. Incomplete and stained prints were rejected. Blood type diseases were also excluded.

Methods:

- The procedure of blood sample collection and fingerprints detections were fully explained to each subject.
- Participants washed their hands thoroughly . Before taking the prints, each participant was instructed to thoroughly wash their hands with soap and water before drying them with a towel to remove any dirt or sweat. To successfully accomplish the movement of the fingers during the technique, they were advised to unwind and cooperate. Fingers were kept from sliding and prints from smudging.
- The fingertip prints from both hands were taken on a pre-designed proforma including the following: participant name, age, gender, blood groups (ABO and Rh) and spaces for each fingertip of both hands (on two separate white papers; each paper was filled with basic details of subjects such as name, sex, age, blood group, and fingerprints of right and left palms).
- The fingertip prints were taken on a white A4 sheet using the ink method illustrated by Cummins and Midlo in 1926**.** The black washable ink ***(****FS-INK 16, Grade A Fingerprint Paste Ink, The Hitt Companies)* was spread with the help of a roller over an inking slab. A 15" x 6"- sized plain glass was used as an inking slab. Rolling the ink roller over the fingers of the subjects was done. The students were asked to press their fingertips on the white paper to transfer their fingerprint impressions as seen in figure (1).



Little Ring Middle Index Thumb Thumb Index Middle Ring Little

Fig. (1): Fingerprints in 10 digits

- The fingertip prints were taken from all ten fingers and patterns were identified. Primary finger patterns (loops, whorls, and arches) according to Galton's classification (Galton, 1892) were analyzed using a powerful magnifying hand lens (*TAG3™ magnifying glass 50 Mm double reading glass optical graded lens with 5x and 10x magnifying capacity*).
- Regarding finger ball patterns, no distinction was made between different types of whorl patterns. Also, a tented arch was just recorded as an arch. The loop was recorded as either an ulnar loop or radial loop.
- The blood sample was collected by pricking the finger with a sterile lancet. A drop of blood from each subject was assimilated with Anti-serum A, Anti-serum B, and Anti-serum D on a microscopic slide. Blood group type were assessed based on the presence or absence of agglutination (Joshi et al., 2016).

Statistical analysis:

Data were entered into the computer and analysed with "IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp". The "Chi-Square test" and "Mont Carlo test" were used to describe qualitative data as numbers and percentages. The significance of the obtained results was judged at the (0.05) level.

Results:

The general distribution of basic fingerprint patterns in all fingers of both hands, concerning the sex of the studied subjects is demonstrated in Table (1). Out of 2000 fingerprints of both hands of 200 participants, the most common type of fingerprint patterns was an ulnar loop in both genders; it was observed in 1092 fingers (54.6%), followed by whorl pattern in 747 fingers (37.4%) , then arch pattern in 108 fingers (5.4%), whereas the radial loop pattern was the least frequenct in both genders; it was observed in 53 fingers (2.6%). There was no statistically significant association between gender and the general distribution of basic fingerprint patterns regarding each specific pattern.

Table (1): Percentage distribution of basic fingerprint patterns in all fingers of both hands in relation to the sex of the studied participants (Total number of fingerprints=2000).

Fingerprints Patterns	Males (n=1000)	Females (n=1000)	Total (n=2000)	Test of significance	P value
Arch	63 (6.3%)	45 (4.5%)	108 (5.4%)		0.345
Radial Loop	26 (2.6%)	27 (2.7%)	53 (2.6%)	χ^2 =3.317	0.984
Ulnar Loop	537 (53.7%)	555 (55.5%)	1092 (54.6%)		0.306
Whorl	374 (37.4%)	373 (37.3%)	747 (37.4%)		0.944

n=number of fingerprints, χ^2: Chi-Square test *statistically significant if P≤0.05 and** highly significant if <0.001.

Table (2) shows fingerprint distribution patterns of the **right hand** in each fingertip in relation to the sex of the participating subjects. There was a statistically significant difference in the frequency of the **right index** arch distribution pattern (P= 0.041*) between males and females and a highly statistically significant difference in the **right index** ulnar loop distribution pattern (P< 0.001**). Moreover, there was a statistically significant difference in the **right middle finger** ulnar loop distribution pattern (P=0.030*).

Table (2): Right-hand fingerprint distribution patterns in each fingertip in relation to the sex of the studied participants.

Right-Hand Fingers	Fingerprints patterns	Males (n=500)	Females (n=500)	Test of significance	P-value
Thumb Finger	Arch	2 (2%)	3 (3%)		0.742
	Radial Loop	0 (0%)	2 (2%)	MC= 2.872	0.522
	Ulnar Loop	52 (52%)	45 (45%)		0.136
	Whorl	46 (46%)	50 (50%)		0.278
Index Finger	Arch	14 (14%)	3 (3%)		0.041*
	Radial Loop	11 (11%)	10 (10%)	MC= 11.847	0.730
	Ulnar Loop	29 (29%)	47 (47%)		< 0.001 **
	Whorl	46 (46%)	40 (40%)		0.166
Middle Finger	Arch	8 (8%)	2 (2%)		0.174
	Radial Loop	2 (2%)	0 (0%)	MC= 6.967	0.522
	Ulnar Loop	67 (67%)	79 (79%)		0.030*
	Whorl	23 (23%)	19 (19%)		0.284
Ring Finger	Arch	3 (3%)	3 (3%)		1
	Radial Loop	1 (1%)	1 (1%)	MC= 0.334	1
	Ulnar Loop	44 (44%)	48 (48%)		0.262
	Whorl	52 (52%)	48 (48%)		0.262
Little Finger	Arch	4 (4%)	3 (3%)		0.724
	Radial Loop	0 (0%)	0 (0%)	MC= 0.611	1
	Ulnar Loop	66 (66%)	71 (71%)		0.156
	Whorl	30 (30%)	26 (26%)		0.282

n=number fingerprints, MC: Monte Carlo test, *statistically significant if P≤0.05 and** highly significant if <0.001.

Table (3) shows fingerprint distribution patterns of the **left hand** in each fingertip in relation to the sex of the participating subjects. There was a statistically significant difference between males and females in the frequency of ulnar loop and whorl distribution patterns (P= 0.004*and 0.015*) in the **left ring finger**.

Table (3): Left-hand fingerprint distribution patterns in each fingertip in relation to the sex of the studied participants.

Left-Hand Fingers	Fingerprints patterns	Males (n=500)	Females (n=500)	Test of significance	P-value
Thumb Finger	Arch	5 (5%)	5 (5%)		1
	Radial Loop	3 (3%)	0 (0%)	MC= 3.474	0.338
	Ulnar Loop	45 (45%)	51 (51%)		0.164
	Whorl	47 (47%)	44 (44%)		0.324
Index Finger	Arch	11 (11%)	12 (12%)		0.708
	Radial Loop	7 (7%)	10 (10%)	$\chi2$ =1.859	0.330
	Ulnar Loop	47 (47%)	38 (38%)		0.084
	Whorl	35 (35%)	40 (40%)		0.172
Middle Finger	Arch	9 (9%)	8 (8%)		0.716
	Radial Loop	0 (0%)	1 (1%)	MC= 1.524	0.756
	Ulnar Loop	66 (66%)	70 (70%)		0.276
	Whorl	25 (25%)	21 (21%)		0.288
Ring Finger	Arch	4 (4%)	4 (4%)		1
	Radial Loop	1 (1%)	2 (2%)	MC= 6.121	0.748
	Ulnar Loop	54 (54%)	37 (37%)		0.004*
	Whorl	41 (41%)	57 (57%)		0.015*
Little Finger	Arch	3 (3%)	2 (2%)		0.744
	Radial Loop	1 (1%)	1 (1%)	MC= 0.247	1
	Ulnar Loop	67 (67%)	69 (69%)		0.510
	Whorl	29 (29%)	28 (28%)		0.704

n=number of fingerprints, MC: Monte Carlo test, χ^2: Chi-Square test *statistically significant if P≤0.05 and** highly significant if <0.001.

Table (4) shows right-handed versus left-handed fingerprint distribution patterns in relation to the sex of the participating subjects. The ulnar loop was the most frequenct in the right hands of males and females. There was a statistically significant difference between males and females regarding the right-hand arch and ulnar loop distribution patterns (P= 0.039* and 0.012*) respectively, with no statistically significant difference regarding the left hands fingerprints distribution patterns in both sexes.

Table (4): right-handed versus left-handed fingerprint distribution patterns in relation to the sex of the studied participants (Total number of fingerprints=2000).

Fingerprints Patterns	Right hand (n=1000) Male (n=500)	Right hand (n=1000) Female (n=500)	Test of significance	P-value	Left hand (n=1000) Male (n=500)	Left hand (n=1000) Female (n=500)	Test of significance	p-value
Arch	31 (6.2%)	14 (2.8%)	χ^2= 8.844	0.039*	32 (6.4%)	31 (6.2%)	χ^2= 0.991	0.820
Radial Loop	14 (2.8%)	13 (2.6%)		0.834	12 (2.4%)	14 (2.8%)		0.708
Ulnar Loop	258 (51.6%)	290 (58%)		0.012*	279 (55.8%)	265 (53%)		0.222
Whorl	197 (39.4%)	183 (36.6%)		0.116	177 (35.4%)	190 (38%)		0.166

n=number of fingerprints, χ^2: Chi-Square test *statistically significant if P≤0.05 and** highly significant if <0.001.

Table (5) and Figure (2) show the frequency of ABO/Rh blood group types in relation to the sex of the studied participants**.** It was found that the majority of the subjects belonged to blood group **"O+"** (41%), followed by **"A+"** (32%), **"B+"** (16.5%), **"AB+"** (5.5%), **"B-"** (2.5%), and **"O-"** (1.5%), respectively, whereas **"AB-"** blood group showed the least frequency (1%). None of the subjects belonged to blood group **"A-"**. There was a high statistically significant difference (P<0.001**) between males and females regarding **"O+ and "B+"** blood groups. Blood group **"O+"** was found to be more in males (٥١%) and **"B+"** was found to be more in females (23%) with no statistically significant association between gender and other blood groups.

Table (5): The frequency of ABO/Rh blood group types in relation to the sex of the studied participants (Number = 200).

ABO/Rh Blood groups	Males (n=100)	Females (n=100)	Total (n=200)	Test of Significance	p value
A +	31 (31%)	33 (33 %)	64 (32%)	MC= 14.286	0.356
A -	0 (0%)	0 (0%)	0 (0%)		---
O +	51 (51%)	31 (31%)	82 (41%)		< 0.001 **
O -	1 (1%)	2 (2%)	3 (1.5%)		0.710
B +	10 (10%)	23 (23%)	33 (16.5%)		< 0.001 **
B -	1 (1%)	4 (4%)	5 (2.5%)		0.104
AB +	6 (6%)	5 (5%)	11 (5.5%)		0.678
AB -	0 (0%)	2 (2%)	2 (1%)		0.394

n=number of participants, MC: Monte Carlo test *statistically significant if P≤0.05 and** highly significant if <0.001.

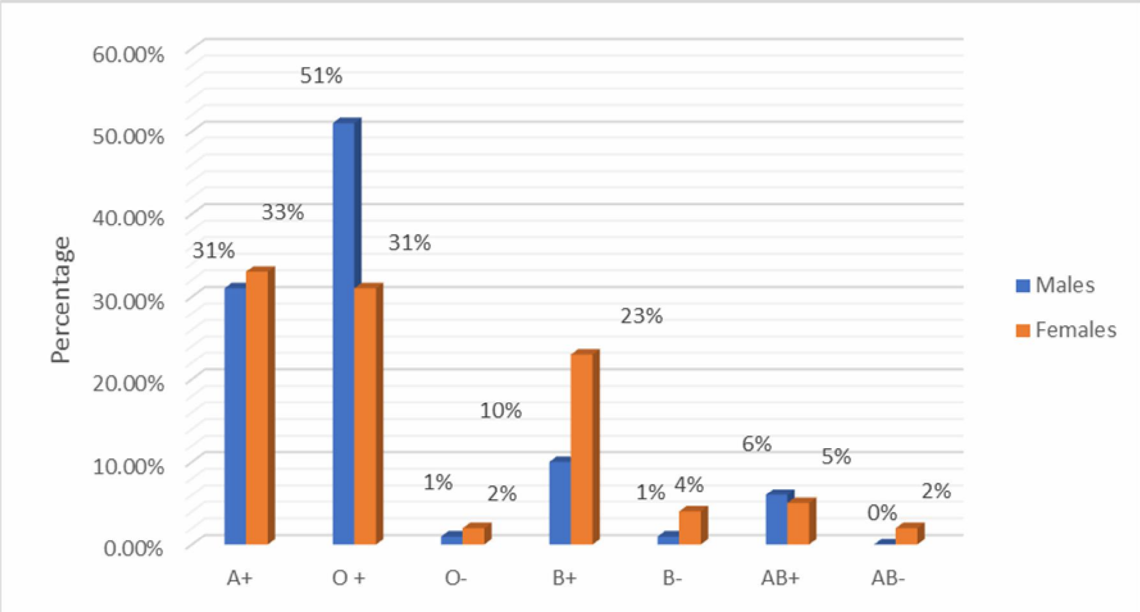


Fig. (2): The frequency of ABO/Rh blood group types in relation to the sex of the studied participants.

Table (6) and figure (3) show the frequency of basic fingerprint patterns in different ABO/Rh blood group types of the studied participants. In all subjects with blood groups "A+, O+, O-, B+, B-, AB+," the ulnar loop had the highest frequency, followed by whorl and arch, then radial loop in that order.There was a highly statistically significant difference in the frequency of fingerprint patterns in subjects with blood groups **"A+"** and **"O-"** (P< 0.001 ** and =0.001 **) respectively. Moreover, the ulnar loop showed the highest frequency, followed by arch and whorl, then the radial loop in subjects with blood groups **"AB-"** with a statistically significant difference (P=0.003 *). There was no statistically significant difference in the frequency of fingerprint patterns in subjects with other blood groups. On the other hand, arch and radial loop distributions were predominantly found in **"O+"** and 0% in **"B+"** and **"AB+"** blood groups. Ulnar loop distribution was predominantly found in **"O+"** and least in **"AB+",** while whorl distribution was predominantly found in **"O+"** and least in the **"AB-"** blood group.

Table (6): The frequency of basic fingerprint patterns in different ABO/Rh blood group types of the studied participants (total number of fingerprints=2000).

ABO/Rh Bl. groups	Arch (n=108)	Radial loop (n=53)	Ulnar loop (n=1092)	Whorl (n=747)	Test of significance	p value
A+	32 (29.6%)	11 (20.7%)	377 (34.5%)	220 (29.5%)	MC= 14.286	< 0.001 **
O +	38 (35.2%)	24 (45.3%)	441 (40.4%)	317 (42.4%)		0.064
O -	20 (18.5%)	15 (28.3%)	166 (15.2%)	129 (17.3%)		0.001 **
B +	0 (0%)	0 (0%)	29 (2.7%)	21 (2.8%)		0.734
B -	8 (7.4%)	2 (3.8%)	51 (4.6%)	49 (6.5%)		0.658
AB +	0 (0%)	0 (0%)	12 (1.1%)	8 (1.1%)		0.926
AB -	10 (9.3%)	1 (1.9%)	16 (1.5%)	3 (0.4%)		0.003 *

n=number of fingerprints, MC: Monte Carlo test *statistically significant if P≤0.05 and** highly significant if <0.001.

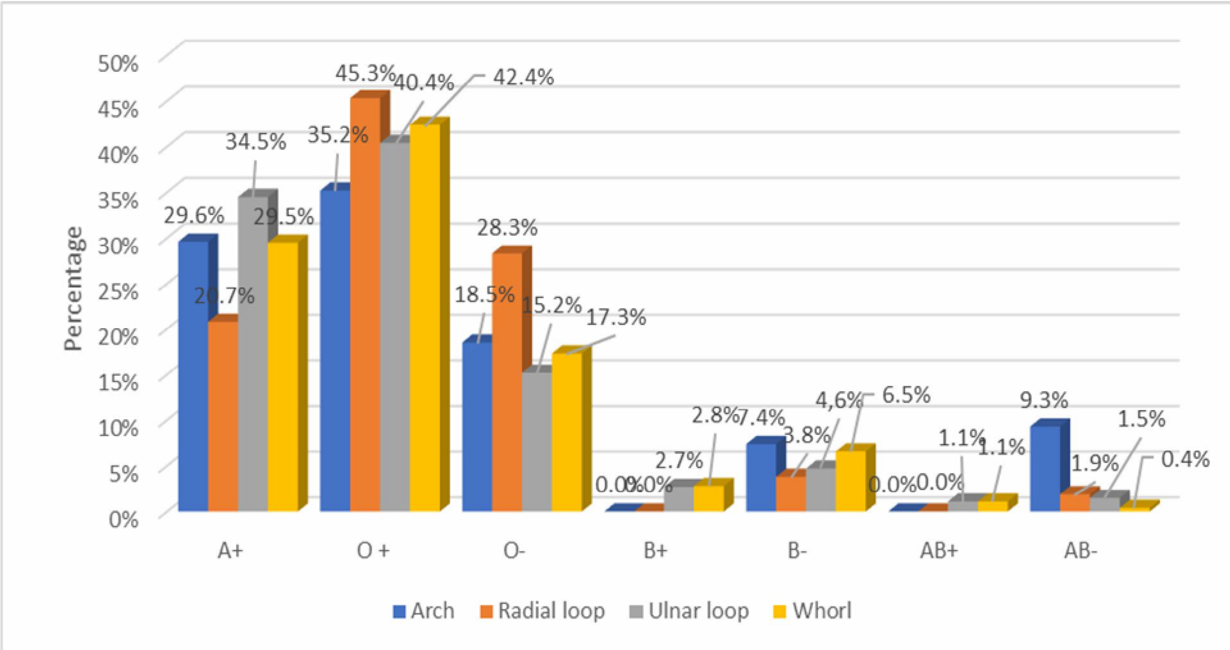


Fig. (3): The frequency of basic fingerprints patterns in different ABO/Rh blood group types of the studied participants.

Table (7) shows the distribution of basic fingerprint patterns of both hands in different ABO/Rh blood groups among males and females of the studied participants. There was a statistically significant difference in the frequency of arch and ulnar loop pattern distribution between males and females with blood group **"O-"** (P< 0.001 **), whorl pattern distribution with blood group **"B+"** (P=0.011*), ulnar loop and whorl pattern distribution with blood group **"B-"** (P=0.015 * and 0.012 *) respectively, and the frequency of ulnar loop pattern distribution with blood group **"AB+"** (P= 0.038 *). There were no statistically significant differences between males and females regarding any other fingerprint patterns in other ABO/Rh blood groups.

Table (7): The distribution of basic fingerprint patterns of both hands in different ABO/Rh blood groups among males and females of the studied participants (total number of fingerprints=2000).

ABO/Rh Blood groups	Fingerprints Patterns	Males (n=1000)	Females (n=1000)	Test of significance	p value
A+	Arch	16 (5.1%)	16 (4.8%)		0.488
	Radial Loop	6 (1.9%)	5 (1.5%)		0.516
	Ulnar Loop	175 (56.5%)	202 (61.2%)	$\chi2$ =1.565	0.074
	Whorl	113 (36.5%)	107 (32.4%)		0.106
	Total	310 (100%)	330 (100%)		
O +	Arch	24 (4.7%)	14 (4.5%)		0.860
	Radial Loop	14 (2.7%)	10 (3.2%)		0.502
	Ulnar Loop	278 (54.5%)	163 (52.6%)	$\chi2$ =0.434	0.248
	Whorl	194 (38%)	123 (39.7%)		0.176
	Total	510 (100%)	310 (100%)		
O-	Arch	10 (100%)	0 (0%)		< 0.001 **
	Radial Loop	0 (0%)	1 (5%)		0.678
	Ulnar Loop	0 (0%)	16 (80%)	MC= 6.107	< 0.001 **
	Whorl	0 (0%)	3 (15%)		0.162
	Total	10 (100%)	20 (100%)		
B+	Arch	8 (8%)	12 (5.2%)		0.204
	Radial Loop	4 (4%)	11 (4.8%)		0.450
	Ulnar Loop	57 (57%)	109 (47.4%)	MC= 4.664	0.084
	Whorl	31 (31%)	98 (42.6%)		0.011 *
	Total	100 (100%)	230 (100%)		
B-	Arch	0 (0%)	0 (0%)		1
	Radial Loop	0 (0%)	0 (0%)		1
	Ulnar Loop	3 (30%)	26 (65%)	MC= 4.023	0.015 *
	Whorl	7 (70%)	14 (35%)		0.012 *
	Total	10 (100%)	40 (100%)		
AB+	Arch	5 (8.3%)	3 (6%)		0.626
	Radial Loop	2 (3.3%)	0 (0%)		0.410
	Ulnar Loop	24 (40%)	27 (54%)	MC= 3.449	0.038 *
	Whorl	29 (48.3%)	20 (40%)		0.346
	Total	60 (100%)	50 (100%)		
AB-	Arch	0 (0%)	0 (0%)		
	Radial Loop	0 (0%)	0 (0%)		
	Ulnar Loop	0 (0%)	12 (60%)	NA	NA
	Whorl	0 (0%)	8 (40%)		
	Total	0 (100%)	20 (100%)		

n=number of fingerprints, χ^2: Chi-Square test, MC: Monte Carlo test, NA: not applicable *statistically significant if P≤0.05 and** highly significant if <0.001.

Discussion:

Many criteria have been used for identification, like sex, race, age, hair, complexion, scars, occupation marks, tattoos, and footprints. However, fingerprints are found to be the most reliable. To date, despite advanced technologies and complex methodologies such as DNA analysis used for personal identification, fingerprints and the ABO/Rh grouping system remain unique. They are permanent, and applicable especially in developing countries like Egypt. They are also accepted as reliable evidence in forensic and medicolegal investigations (Murugan and Karikalan, 2014; Shah and Jayaraj, 2015 and Tandon et al., 2017).

The association between variables like ABO/Rh blood groups and fingerprint patterns may be more beneficial than using a single parameter for the accurate identification of an individual and differentiation of his sex. Additionally, it can narrow the search for a criminal or suspected person, particularly when there is scarce or no available identifying data (Sandhu et al., 2017).

This cross-sectional observational study was carried out on 200 individuals. The participants belonged to the same age and ethnic group. The present work was an approach to screening fingerprints patterns in different ABO/Rh blood groups in a selected sample of the Egyptian population and studying their role in sex determination.

The distribution of fingerprint patterns in both hands of individuals and their relationship with gender and different ABO/Rh blood groups were evaluated and analyzed statistically. It has been noticed that the most frequently observed fingerprint pattern was the ulnar loop pattern in both genders (53.7% in males and 55.5% in females), which is consistent with other previous studies done on the Indian population (Mutalik et al., 2013; Umraniya et al., 2013; Krishnan et al., 2016; Tandon et al., 2017 and Vankara et al., 2021). On the other hand, the radial loop pattern was the least observed in both genders (2.6% in males and 2.7% in females), as in studies carried out by Gutierez et al. (2012) and Sandhu et al. (2017). Studies in other African regions have reported similar fingerprint patterns but with variations in percentages, as in Odukuma and Igbigbi, (2005); Shrestha et al., (2019) and Chukwumah, (2020). However, the results of the present work are inconsistent with the results obtained by Desai et al. (2013) and Joshi et al. (2016), who reported that the whorl pattern was more common in men.

In the present work, there was no statistically significant association between gender and the general distribution of basic fingerprint patterns regarding each specific pattern. Sudikshyathe et al. (2018) reported that the relationship between primary patterns of fingerprints and sex is statistically not significant.

By observing the fingerprint distribution patterns in each fingertip in the right and left hands in relation to the sex of the studied participants, there was a highly statistically significant difference between males and females regarding the right index, right middle finger, and left ring finger pattern distribution. This finding contradicts the results of a very recent study conducted by Chukwumah (2020) on 200 students at “Ambrose Alli University, Ekpoma-Nigeria”; the researcher observed no association between fingerprint pattern distribution and gender regarding each finger.

By comparing right hand versus left hand fingerprint distribution patterns in relation to the sex of the participating subjects**,** it was found that the ulnar loop was the highest frequency in both hands of males and females. Moreover, there was a statistically significant difference between males and females regarding the right-hand arch and ulnar loop distribution pattern with no statistically significant difference regarding the left hand fingerprint distribution patterns. Ujaddughe et al. (2015) reported that the pattern of fingerprint distribution was similar in both hands for both sexes except that the males had more arches on the right hand (53%) than the females, who had more arches on the left hand (57.1%), which was not statistically significant.

The present findings showed that most of the subjects (41%) belonged to the blood group **"O+",** whereas the "**AB-"** blood group showed the least frequency (1%). Moreover, blood group **"O+"** was found to be more in males (٥١%) and **"B+"** more in females (23%) with a highly statistically significant difference between males and females regarding **"O"+ and "B+"** blood groups, indicating a highly statistically significant association between gender and **"O+" "B+"** blood groups with no statistically significant association between gender and other blood groups.

Similar results were published by Patil et al. (2014); Chaudhary et al. (2017), and Vankara et al. (2021) with different percentages. On the other hand, a study in India carried out by Joshi et al. (2016) reported that blood group **"B+"** was the most common, followed by blood group **"O+"** and the last one was **"O-"** among all participants. This diversity of observations could be explained by the ethnic, racial, and geographical variation in the population studied.

In addition, the distribution of the primary fingerprint patterns in association with ABO/Rh blood groups is the same for **"A+, O+, O-, B+, B⍰** and **AB+"**; the ulnar loop represented the highest frequency, followed by whorl and arch, and then the radial loop pattern, which showed the least frequency**.** These findings are in accordance with Eboh(2013), Ekanem et al. (2014), and Shrestha et al. (2019). On the other hand, arch and radial loop distributions were highest in **"O+"** and least in **"B+"** and "**AB+"** blood groups. Ulnar loop distribution was highest in **"O+"** and least in **"AB+"** and whorl distribution was highest in **"O+"** and least in the **"AB-"** blood group. Shivhare et al. (2017) reported that loops were highest in the **"B"** blood group and lowest in the **"AB"** blood group. Whorls are highest in "**A"** and lowest in **"B"** blood groups. The arches were highest in "**AB"** and lowest in "**B"**. Although ulnar loop fingerprint patterns were most commonly seen in all ABO blood types, earlier studies found no or just a weak association between them, which could be owing to the limited sample sizes of previous studies (Sandhu et al., 2017).

By evaluating the distribution of basic fingerprint patterns of both hands in different ABO/Rh blood groups among males and females, there was a statistically significant difference in the frequency of arch and ulnar loop pattern distribution between males and females with blood group "**O-",** whorl pattern distribution with blood group **"B+"**, ulnar loop and whorl patterns distribution with blood group **"B-",** and ulnar loop pattern distribution with blood group **"AB+"**. There were no statistically significant differences between males and females regarding any other fingerprint patterns in other ABO/Rh blood groups.

In a study conducted in India by Joshi et al. (2016), a statistically significant association between the distribution of fingerprint patterns in different ABO/Rh blood groups among males and females coincides with our results. On the contrary, Shrestha et al. (2019) from Nepal found no significant association between ABO/Rh blood groups and fingerprints in both sexes. These discrepant findings may be due to racial, genetic, or environmental factors.

Conclusion:

Fingerprints and ABO/Rh blood groups can be detected by simple and inexpensive techniques to be used as an additional tool in forensic investigations in the Egyptian population. From the present work, it can be concluded that the most frequently observed fingerprint pattern was the ulnar loop in both genders. There was no statistically significant association between gender and the general distribution of basic fingerprint patterns. Thus, depending on fingerprint patterns alone may not be so accurate for sex dimorphism. However, its significant distribution in both genders may be related to individual digits in both hand, which needs further studies. Moreover, right-hand fingerprint distribution patterns may have more suggestive value for sex determination than the left hand in the Egyptian population. In addition, there was a highly statistically significant association between gender and **"O+/B+"** blood groups. Ulnar loop patterns were most common in all blood groups. There was an association between fingerprint patterns distribution in **"O-, B+, B-, AB+"** blood groups and gender differentiation. Thus, prediction of gender in certain blood groups may be possible based on fingerprints patterns. Digital patterns like "loops, whorls, and arches" remain an important feature for sex identification and possibly determining ethnic groups.

Recommendations:

A similar study can be replicated on a larger scale for quantitative study as well. However, to establish a solid association between these characteristics, more broad and detailed research investigations using digital analysis among different populations, taking into account racial and ethnic backgrounds, are required.

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دور أنماط بصمات الأصابع وفصائل الدم ABO / Rh في تحديد الجنس بين عينة من السكان المصريين

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[١] **قسم الطب الشرعي والسموم الإكلينيكية - كليه الطب - جامعه المنصورة - جمهورية مصر العربية**

استخدمت بصمات الأصابع كطريقة دقيقة لتحديد الهوية منذ فترة طويلة. تم تنفيذ العمل الحالي لفحص أنماط بصمات الأصابع في مجموعات الدم ABO / Rh المختلفة ودراسة دورها في تحديد الجنس في عينة مختارة من السكان المصريين. أجريت هذه الدراسة على ٢٠٠ من طلاب الطب الأصحاء بكلية الطب جامعة المنصورة. تم جمع عينات الدم وتحليلها لفصائل الدم ABO / Rh ثم أخذ بصمات الأصابع لكلتا اليدين على ورق أبيض A4 باستخدام حبر أسود قابل للغسل واستخدام عدسة اليد المكبرة لاكتشاف نمط بصمات جميع الأصابع. كان النوع الأكثر شيوعًا من أنماط بصمات الأصابع هو االأنشوطة الزندية في كلا الجنسين مع وجود فرق ذي دلالة إحصائية بين الذكور والإناث في أنماط توزيع السبابة اليمنى والإصبع الأوسط الأيمن والبنصر الأيسر وقد لوحظ أنه قد يكون لأنماط بصمات اليد اليمنى دلالة أكثر علي تحديد الجنس من اليد اليسرى في السكان المصريين. وكذلك كان هناك فرق ذو دلالة إحصائية عالية بين الذكور والإناث في مجموعتي الدم "+O و+B " مع وجود فرق كبير إحصائياً في توزيع أنماط بصمات الأصابع في مجموعات الدم " + A , -O , -AB ". علاوة على ذلك ، كان هناك ارتباط بين توزيع أنماط بصمات الأصابع في فصائل الدم " -O ، + B، -B، +AB "والتمايز بين الجنسين. قد يكون من الممكن التنبؤ بالجنس في مجموعات دم معينة بناءً على أنماط بصمات الأصابع. وبذلك تظل أنماط الأصابع (الأنشوطات،الدومات والمقوسات) مهمة لتحديد الجنس وربما تحديد المجموعات العرقية.